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TENDENCIES OF CLIMATIC INDICES IN THE ROMANIAN IRRIGATION SYSTEMS

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Keywords: drought, water deficit, climate changes, irrigation system

ABSTRACT

The aim of this investigation was to evaluate the tendencies of climate aridity of areas where irrigation systems are present, based on meteorological parameters such as precipitations, potential evapotranspiration and water deficit as expressed by the average value of the ratio between precipitation and potential evapotranspiration (P/ETP). The impact of climate changes was done by comparing the time periods of 1961–2000 with 2001–2016, at NUTS5 level where there is potential for crop irrigation. The results showed that for the time period of 2001–2016, the mean values of precipitations decreased down to 399 mm, and the potential evapotranspiration increased up to 716 mm. Therefore, the water deficit expressed as average value of the ratio P/ETP decreases from 0.594 to 0.557. There is a higher water deficit in most areas where the irrigation systems are present, and, therefore, the near future trend is to increase the water deficit over time.

INTRODUCTION

Although droughts are a meteorological phenomenon, from a water management point of view, they are usually defined in the literature as the magnitude of the reduction in water supply, the normal variation in water supply, the impacts of the reductions, especially on human activities [1]. Prediction scenarios on climate changes for Romania exhibit a dramatic evolution of the mean temperatures and precipitations. It is expected that precipitations will decrease and temperatures will increase during summer season, which lead to potential conditions to increase the intensity and frequency of droughts [3].

During the last decades, the drought phenomenon has expanded as a result of deforestation, destruction of forest protection belts etc., which took place on most part of the land (agricultural and forestry). The potentially affected areas by desertification in Romania are mainly located in Dobrogea, Muntenia and southern Moldavia regions. In these areas the main viable irrigation systems are also located.

Water resources and their quality are constantly decreasing with increasing aridity as a result of climate warming. According to some climate scenarios, the droughts will persist in areas with critical climate from Europe, and these regions will suffer from pronounced drought, heat waves, water shortage and reduced agricultural production [4].

The objective of this paper was to evaluate the trends of climate aridity of areas where irrigation systems are present, based on meteorological parameters such as precipitations, potential evapotranspiration and water deficit as expressed as an average value of the ratio between precipitation and potential evapotranspiration (P/ETP).

MATERIAL AND METHOD

The water deficit for agricultural crops was evaluated by calculating the ratio between elements that determine the water balance, namely the annual precipitation (P) and potential evapotranspiration (ETP) values for the time periods of 1961-2000 and 2001–2016, and for the communes where there is potential for crop irrigation. The potential evapotranspiration was evaluated by using the Penman-Monteith method [2].

The average daily climate data for climatic parameters for the time periods of 1961–2000 and of 2001–2016 were spatially distributed across each administrative territorial unit (UAT), using the MARS methodology to provide deviations from averages across a 10' *x* 10' longitude *x* latitude grid. The evaluations of the trend of precipitations, potential evapotranspiration and water deficit were done at commune level – NUTS 5 fitted within the viable irrigation systems from Romania. The Arc GIS software was used for aggregation of data.

RESULTS AND DISCUSSIONS

Water deficit in agriculture can cause the farmer's vulnerability to future climate changes, and is emphasized by problems encountered in irrigation field. Arable crops (including cereals and oil crops) are the most vulnerable to climate changes and the yields had declined significantly in years with drought conditions. Easily access to water resources is important in irrigation, but excessive fragmentation of half of the utilized agricultural area, together with difficulties of creating functional associations of water users, are real obstacles.

The actual irrigated area greatly varies from year to year depending on rainfall. It is estimated that about 11% of the agricultural area is covered by economically viable or marginally viable irrigation systems. There are also regional differences, especially as a result of variable rainfall distribution and implicitly of irrigation requirements. North-west, west and center of the country require less irrigation water, while the southern and south-east parts of the country, water-affected areas, have a higher coverage with irrigation systems.

The obtained results for counties where are irrigation systems are presented in Table 1. It is noted that for the time period of 2001–2016, the rainfall presented as mean values for all counties decreased down to 399 mm, and the potential evapotranspiration increased up to 716 mm. Therefore, the water deficit expressed as an average value of the ratio between precipitation and potential evapotranspiration (P/ETP) decreases from 0.594 to 0.557. It can also be observed that the values of the variation interval of the precipitations decreased during the time period of 2001–2016 (290–758 mm) as compared to the time period of 1961–2000 (305–761 mm), whereas the values of the variation interval of the potential evapotranspiration increased during the time period of 2001–2016 (692–748 mm) as compared to the time period of 1961–2000 (663–716 mm).

In the literature, the ratio between precipitation and potential evapotranspiration (P/ETP) is also known as the UNESCO Aridity index [5]. This approach is attractive for use because it is based only on two main parameters that define aridity. UNESCO [5] proposed a classification of the climatic zones based on the values of aridity index in which the upper boundary is set at 0.5 for dry sub-humid zones, and the lower boundary between the arid and hyper-arid zones is set at 0.03 [5]. The boundaries for the arid zone are defined between 0.03 and 0.2. Also a semi-arid zone is defined with boundaries between 0.2 and 0.5.

Table 1

Values of the annual precipitation (P, mm), annual potential evapotranspiration (ETP, mm) and of water deficit ratio (P/ETP) for the time periods of 1961-2000 and of 2001-2016, for counties where there is actual potential for crop irrigation

Crt. No.	County	Arable land (ha)	P/ETP	P	ETP	P/ETP	P	ETP
			2001-2016			1961-2000		
1	Arad	41,795.31	0.400	297	742	0.450	320	710
2	Bacau	5,756.47	0.714	534	748	0.748	536	716
3	Botosani	3,748.83	0.645	453	702	0.654	439	671
4	Braila	270,482.14	0.417	298	715	0.465	319	684
5	Buzau	26,491.03	0.558	405	725	0.582	404	694
6	Calarasi	242,727.08	0.413	294	712	0.458	312	682
7	Constanta	111,932.99	0.430	308	715	0.459	314	685
8	Covasna	10,254.66	1.058	758	717	1.109	761	686
9	Dambovita	44,918.24	0.752	522	695	0.800	532	665
10	Dolj	124,939.40	0.414	296	716	0.451	309	685
11	Galati	67,749.36	0.405	290	716	0.445	305	685
12	Giurgiu	68,018.95	0.600	428	713	0.638	436	682
13	Ialomita	86,807.71	0.408	293	719	0.465	320	688
14	Iasi	23,680.31	0.648	468	721	0.676	467	691
15	Ilfov	1,975.95	0.729	519	712	0.776	529	682
16	Neamt	3,367.94	0.685	490	715	0.731	501	685
17	Olt	75,610.94	0.462	328	711	0.496	338	680
18	Prahova	21,289.43	0.661	479	725	0.674	468	693
19	Teleorman	44,411.99	0.415	295	712	0.442	301	681
20	Tulcea	70,010.29	0.426	304	713	0.455	310	683
21	Vaslui	44,956.01	0.409	294	720	0.458	316	689
22	Vrancea	27,010.56	0.628	435	692	0.648	429	663
	Romania	**1,417,935.59**	**0.557**	**399**	**716**	**0.594**	**407**	**686**

From the values presented in table 1 it can be seen that for the time period of 2001–2016, a number of 11 counties falls into the semi-arid zone, 5 counties falls into the dry sub-humid zone, and 6 counties falls into the humid zone. When compared with the time period of 1961–2000, it can be seen that the number of counties in semi-arid and dry sub-humid areas has increased.

Figure 1 illustrates the evolution of annual precipitations (P) for the time period of 2001–2016 as compared to the time period of 1961-2000 at the territorial administrative unit (UAT) level (NUTS 5). It was observed that in many areas where there is potential for crop irrigation the annual precipitation (P) has decreased by 123 mm.

Figure 2 illustrates the evolution of the annual potential evapotranspiration (ETP) accumulated over the time period of 2001–2016 as compared to the time period of 1961–2000 at the territorial administrative unit (UAT) level (NUTS 5). It was observed that the annual potential evapotranspiration (ETP) has increased within the range of 24–35 mm in areas where there is a potential for crops irrigation.

Figure 3 illustrates the evolution of water deficit (P/ETP) over the time period of 2001–2016 as compared to the time period of 1961–2000 at the territorial administrative unit (UAT) level (NUTS 5). It was observed that the water deficit (P/ETP) has increased in most areas where there is a potential for crop irrigation in the range of 0.755–1.197 mm.

There is a higher water deficit in the most areas of the viable irrigation systems which require irrigation application, and the trend in the near future is to increase the water deficit over time. Droughts can last from a few days to a few months, affecting the results of the entire year of agricultural production.

In a future time horizon, for example until the year of 2030, Romania will be affected in most of the agricultural areas by a severe water deficit. Through the efficient use of the water resource until the year of 2050, the agricultural areas of our country will be affected by an average water stress, and with a water exploitation index of 20–40 %.

Figure 1. Evolution of annual precipitation (P) within the time period of 2001–2016 in comparison with the time period of 1961–2000, at communes level (NUTS 5)

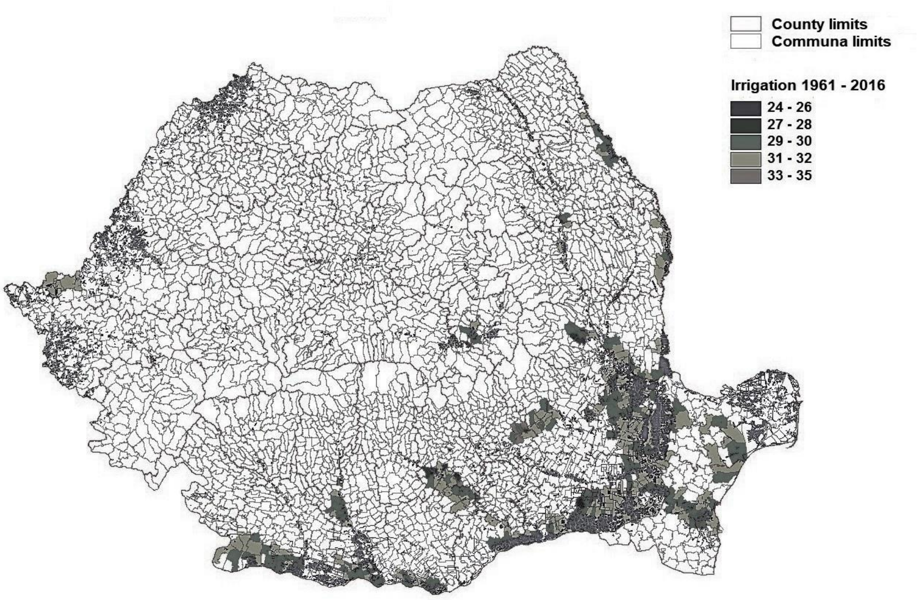

Figure 2. Evolution of annual potential evapotranspiration (ETP) within the time period of 2001–2016 in comparison with the time period of 1961–2000, at communes level (NUTS 5)

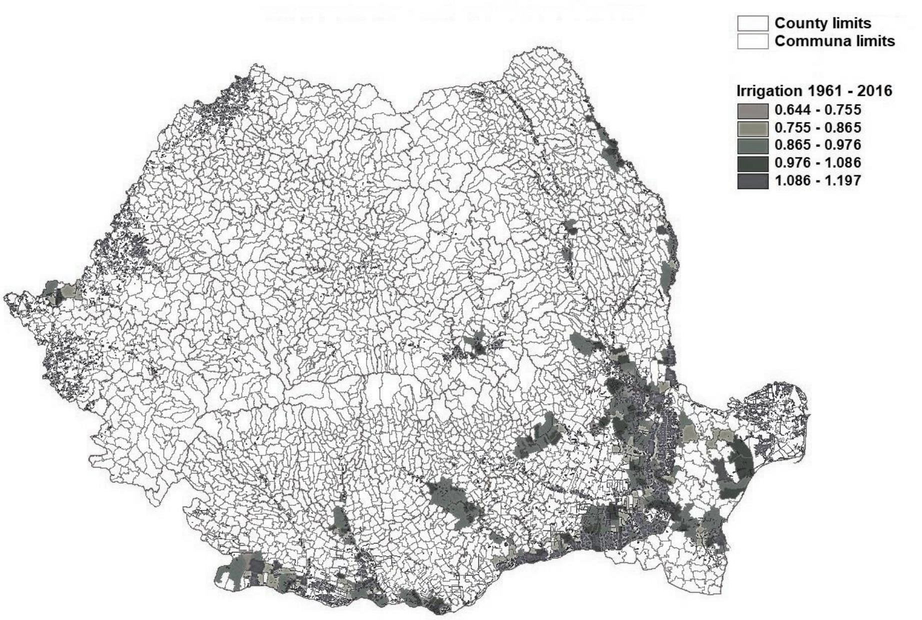

Figure 3. Evolution of the water deficit (P/ETP) within the time period of 2001–2016 in comparison with the time period of 1961–2000, at communes level (NUTS 5)

CONCLUSIONS

Evaluation of the trends of climate aridity of areas where irrigation systems are present, based on meteorological parameters (e.g. precipitations, potential evapotranspiration and water deficit as expressed by the average value of the ratio between precipitation and potential evapotranspiration) led to the following conclusions:

1. Irrigations are applied in areas that are located mostly within the main irrigation systems from Muntenia, southern Moldavia and Dobrogea regions. Within these areas there is also a higher water deficit and the drought phenomenon has increased over time.

2. For the time period of 2001–2016, the rainfall presented as mean values for all counties decreased down to 399 mm, and the potential evapotranspiration increased up to 716 mm. Therefore, the water deficit expressed as an average value of the ratio between precipitation and potential evapotranspiration (P/ETP) decreases from 0.594 to 0.557.

3. In many areas where there is potential for crop irrigation the annual precipitation (P) has decreased by 123 mm, the annual potential evapotranspiration (ETP) has increased within the range of 24–35 mm and the water deficit (P/ETP) has increased in most areas in the range of 0.755–1.197 mm.

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